



May 4, 2022

# FAA CLEEN III Consortium Industry Day

GE Aviation

# GE Aviation: Committed to a more sustainable future for aviation



## Products

Developing and maturing technology solutions to dramatically reduce aircraft emissions



## Industry Partnerships

Partnering globally to shape and guide industry dialogue and actions



## Operations

Accelerating efforts to achieve carbon neutrality in our facilities by 2030



## RISE PROGRAM

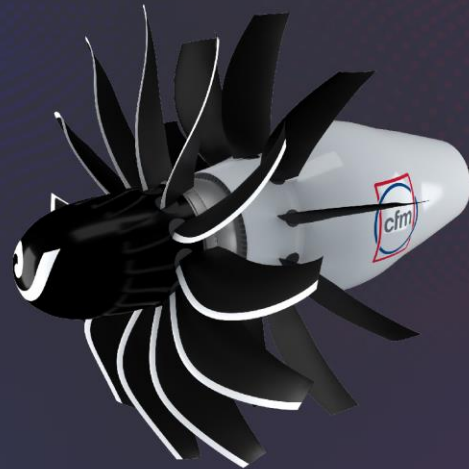
REVOLUTIONARY INNOVATION FOR SUSTAINABLE ENGINES

TARGETING MORE THAN **20%** LOWER CO<sub>2</sub> EMISSIONS

Advancing **open fan**  
architectures

Advanced materials

**100% SAF**,  
hydrogen capability



Step change in  
**propulsive efficiency**

**Hybrid-electric**

Build on  
**proven technologies**

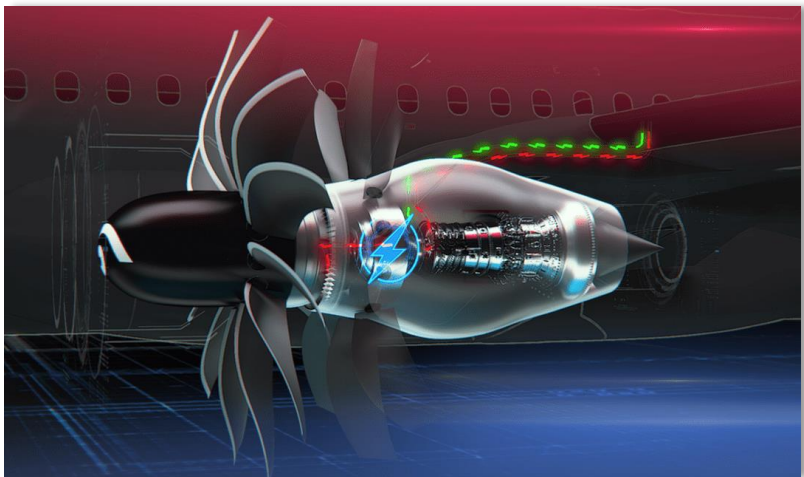
Technology Maturation

Ground & flight tests

EIS by the mid-2030s



# CFM RISE Technologies



## Anticipated Benefits



- Noise: 13 EPNdB cum margin relative to Stage 5
- Combined Fuel Burn: 20+% reduction relative to current CFM LEAP\* engine
- Targeting NOx reduction for a future high overall pressure ratio engine cycle, equivalent to 70% margin to the CAEP/8 standard at 30 OPR

## Objectives

- **Open Fan:** develop unducted single fan architecture
- **Low emissions combustor:** develop low NOx and nvPM combustor and enable compact, high OPR core to achieve 20% fuel burn
- Develop **Advanced Thermal Management System** and waste heat recovery system
- **Hybrid Electric Generator:** develop integrated electric-power generation system within the engine

## High Level Schedule

|                                    | 2021 | 2022 | 2023 |
|------------------------------------|------|------|------|
| Design                             |      |      |      |
| Fabrication, Procurement, Assembly |      |      |      |
| Technology Demonstration           |      |      |      |

## Milestones

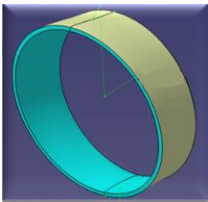
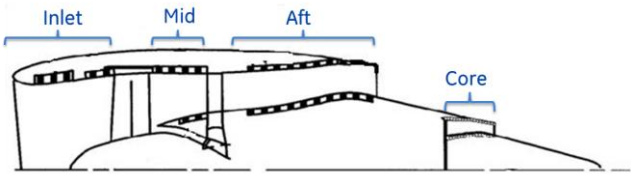
- 10+ design reviews completed
- 3 tests initiated
- Test components fabrication started

\*CFM56 and LEAP engines are products of CFM International, a 50-50 joint company between GE and Safran Aircraft Engines.

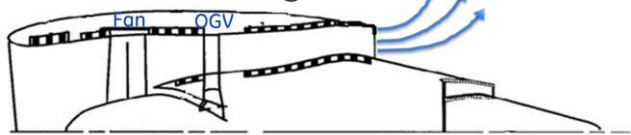


# CLEEN III Advanced Acoustics

## Novel Liners



## Fan Source Strength Reduction



## Anticipated Benefits:



- Novel Liner:  
2 EPNdB cumulative noise reduction relative to SDOF w/ neutral performance impact  
or
- Fan Source Strength Reduction Concept:  
1 EPNdB cumulative noise reduction w/ performance neutral impact

## Objectives:

- Develop Novel Acoustic Liners.
- Develop Fan Source Strength Reduction Concepts

## Work Statement:

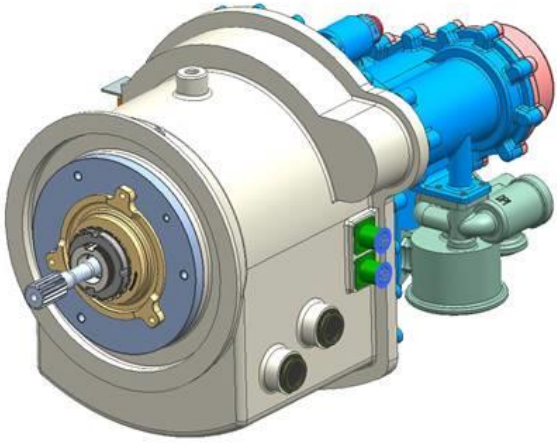
- Execute subscale acoustic test of fan source strength reduction concept hardware developed under CLEEN II
- Down-select most promising technology (novel liner or fan source strength reduction concept as predicted on a production engine platform
- Complete detailed designed of full-scale down-selected technology
- Manufacture full-scale down-selected hardware suitable for testing

## High Level Schedule

| Advanced Acoustics                               | CY 2022 |    |    |    | CY 2023 |    |    |    | CY 2024 |    |    |    | CY 2025 |    |    |    |
|--------------------------------------------------|---------|----|----|----|---------|----|----|----|---------|----|----|----|---------|----|----|----|
| Task                                             | Q1      | Q2 | Q3 | Q4 | Q1      | Q2 | Q3 | Q4 | Q1      | Q2 | Q3 | Q4 | Q1      | Q2 | Q3 | Q4 |
| <b>Full Scale Hardware Design Phase</b>          |         |    |    |    |         |    |    |    |         |    |    |    |         |    |    |    |
| Advanced Acoustic Liner Design                   |         |    |    |    |         |    |    |    |         |    |    |    |         |    |    |    |
| Fan Source Strength Reduction Concept Design     |         |    |    |    |         |    |    |    |         |    |    |    |         |    |    |    |
| Downselect Technology                            |         |    |    |    |         |    |    |    |         |    |    |    |         |    |    |    |
| Downselected Technology Final Design             |         |    |    |    |         |    |    |    |         |    |    |    |         |    |    |    |
| <b>Fabrication, Procurement and Assembly</b>     |         |    |    |    |         |    |    |    |         |    |    |    |         |    |    |    |
| Fabricate Part(s) for Down-selected Design       |         |    |    |    |         |    |    |    |         |    |    |    |         |    |    |    |
| <b>Technology Demonstration Phase</b>            |         |    |    |    |         |    |    |    |         |    |    |    |         |    |    |    |
| Execute subscale fan test of fan source strength |         |    |    |    |         |    |    |    |         |    |    |    |         |    |    |    |

- Delayed subscale test due to facility availability
- All deliverable target dates within period of performance
- Design efforts progressing based on revised schedule

# CLEEN III MESTANG III



## Anticipated Benefits:

- More Efficient +/- 270Vdc generator with high power density and increased fuel savings
- New cooling method for increased thermal performance
- Self contained oil system

## Risk/Mitigation Plans:

- Risk : Oil Pump performance failed to meet requirements  
Mitigation : Lab test with dummy generator

## Objectives:

Mature a +/- 270Vdc electric generator development as part of an integrated more-electric primary power system

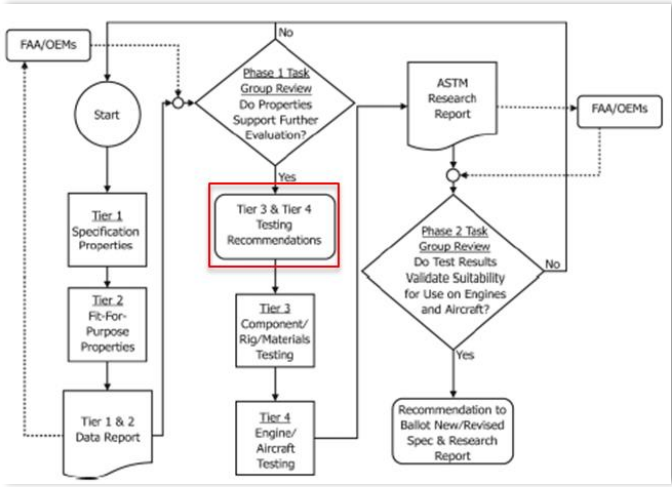
## Work Statement:

- Design and develop a 90 kW, +/- 270Vdc generator to address requirements of mid-size aircraft, business jets.
- Improved power generation system design with increased power density at lower cost.

## Project Milestones

- ✓ Program Kick Off – October 1, 2021
- ✓ FAA Consortium – November 2, 2021
- ✓ Complete System Requirement Document (SRD) – November 30, 2021
- Preliminary Design Review – May 31, 2022
- Critical Design Review – August 31, 2022
- Complete Procurement of Hardware – October 31, 2022
- Complete Prototype build – January 15, 2023
- Prototype testing with shared Oil – February 28, 2023
- FAA Demo and Final Report – March 31, 2023

# Sustainable Aviation Fuel



## Anticipated Benefits

- Advance the approval of a practical candidate SAF with perceived benefits over nominal drop-in SAF
- Accelerate the standardization and therefore the introduction of 100% SAF

## Objectives

- Support qualification of candidate SAF – test/demo
- Advance standardization of 100% SAF

## Work Statement:

- Evaluate 100% & 50% (if needed) of CPK-0 SAF for combustor (FAR\*) operability/emissions
- Help develop ASTM standard of 100% SAF

## High Level Schedule

|                                                | 2021 | 2022 | 2023 | 2024 |
|------------------------------------------------|------|------|------|------|
| Fuel Testing                                   |      |      |      |      |
| Development of Fuel Specification for 100% SAF |      |      |      |      |
| Final Report                                   |      |      |      |      |

\*Full Annular Combustor Rig



Building a world that works